SCIENCE

FRIDAY, SEPTEMBER 5, 1913

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THE ORBITS OF FREELY FALLING BODIES

THE path described by a body falling freely from a considerable height above the surface of the earth presents a problem of interest alike to the mathematical and to the experimental physicist. The former sees in it a capital application of the principles of "relative motion"[1] and the latter sees in it a promising way of demonstrating the rotation of the earth. It has attracted perennial attention for more than a century and has been frequently referred to in this journal during the past decade.

The mechanical aspects of this problem were first carefully considered by Gauss and Laplace one hundred and ten years ago. Gauss's equations of motion for a falling body were furnished in a letter to Benzenberg, who was interested especially in the proper interpretation of experimental results. Gauss's solution of the problem is now accessible in the fifth volume of his collected works. He concluded that in addition to the obvious easterly deviation there should be a small meridional deviation towards the equator from the plumb line defined by a bob suspended from the initial position of the body and normal to some plane of reference below. It seems probable that this latter conclusion prompted Laplace to reinvestigate the subject, for he published a very remarkable paper in May, 1803, in the *Bulletin de la*

[1] This means only that account must be taken of the variations in position of some of the axes or planes of reference with the lapse of time. Why such motion should have been called "relative" and the less complex motion called "absolute" is a question worthy of investigation in the history of mechanics.

Société Philomatique, in which he invites special attention to his conclusion that there is no meridional deviation towards the equator. In view of this discrepancy between these preeminent authors it is a surprising circumstance that nearly all subsequent writers on the subject should have followed Gauss; and it is still more surprising that the more comprehensive and more suggestive, though more difficult, treatment of the problem by Laplace should have been little noticed and less followed by recent authors. Since the appearance of the papers just referred to by Gauss and Laplace only one author, until quite recently, appears to have considered the subject worthy of an independent investigation. This author is Poisson, who published in 1838 an important memoir on the theory of gunnery (in the *Journal de l'École Polytechnique,* Tome XVI.) of which a freely falling body presents a special case. As regards the meridional deviation in question Poisson goes one step further than Gauss and Laplace and leads us to infer (correctly) that his investigation shows no deviation either towards or away from the equator.

My attention was called to this subject about ten years ago, chiefly through the communications concerning it published in this journal by Professor Cajori and Professor E. H. Hall. A casual reading of the papers of Gauss, Laplace and Poisson indicated that they ought all to agree essentially, since they all limit themselves to terms of the first order of approximation of the small quantities involved, especially the angular velocity of the earth, which is obviously a fundamental factor in any solution of the problem. In the meantime, other occupations have led me to neglect this branch of geophysics until my attention was reattracted to it by the suggestive papers of Professor William H. Roever published recently in the *Transactions of the American Mathematical Society.*[2] A preliminary survey of the subject indicated that the obscurities and the discrepancies presented by it could be removed only by an independent investigation founded on present-day knowledge of geodesy. Such an investigation has been made and is now available to the mathematical physicist in Nos. 651–652 of the *Astronomical Journal* (August 4, 1913) under the title "The Orbits of Freely Falling Bodies." The object of this communication is to explain briefly for the information of the general reader the salient features of the subject, the sources of its obscurities, the requirements of a precise and correct determination of the orbits in question, the new results reached, and the reasons why they differ in certain important respects from those hitherto considered valid.

The motion of a falling body depends on three elements, namely: (1) the rotation of the earth; (2) the attraction of the earth; and (3) the difference between geocentric and geographic latitude. The effect of rotation is expressed in the equations of motion of a falling body by terms involving both the first and the second powers of the earth's angular velocity. In general, following Gauss, Laplace and Poisson, terms in the second power of this velocity have been neglected. It turns out that the meridional deviation is a term of the second order in this velocity and other quantities of the same order. Hence it failed to appear in the investigations of the above-named authors, or appeared only as a mathematical fiction and with the wrong

[2] "The Southerly Deviation of Falling Bodies," Vol. XII., No. 3, July, 1911; and "The Southerly and Easterly Deviations of Falling Bodies in an Unsymmetrical Gravitational Field," Vol. XIII., No. 4, October, 1912.

sign in the case of Gauss. The effect of the attraction of the earth presents difficulty, for the earth is not centrobaric, though many authors have assumed it to be such. Gauss and Laplace undoubtedly understood the nature of this difficulty: Laplace's paper (referred to above), is, indeed, entirely satisfactory even now so far as its generalities are concerned. But the necessary observational knowledge, since accumulated, was not available to these pioneers. Each of them was justified, perhaps, in assuming that the effect of the square of the angular velocity would be negligible and that the attraction would be sensibly what has been generally, but now quite vaguely and inappropriately, called "gravity" or "acceleration of gravity," and expressed by the letter g. But this attraction varies certainly with the latitude of the position of the falling body and possibly also with its longitude, and it is not identical with the resultant acceleration due to the attraction and to the rotation of the earth. In respect to both of these points the details of the papers of Gauss, Laplace and Poisson along with the papers of their followers, are all, so far as I am aware, not only obscure, but inadequate. Closely related to the question of the earth's attraction of a falling body is the distinction between its varying geocentric latitude and the constant geographical latitude of the plumb line to which the orbit of the body is referred. This distinction is essential to a correct determination of the meridional deviation, but its fundamental importance does not appear to have been recognized hitherto.

Failure on the part of the earlier authors to perceive the essential rôles of these elements and a tendency to avoid the complications they entail in dealing with the differential equations of motion, account completely for the obscurities and the confusion which initially beset the modern reader who attempts to understand the present extensive literature of this subject. The admirably conceived investigation of Laplace, since published as Chapitre V., Tome IV., of his Mécanique Céléste, presents additional difficulties by reason of his autocratic and unnecessary neglect of terms, without assigning their relative magnitudes, and by reason of his ready suppression, after the fashion of his day, of the identity of any quantity by calling it unity. Following Gauss, many recent authors also after neglecting terms of the second order in their equations of motion, have proceeded to get such terms by a purely mathematical process which has no warrant in the physical circumstances of the case. It has been necessary, therefore, in order to remove the prevailing uncertainties of the subject, to reinvestigate it, avoiding precedent and visualizing the conditions of the problem in the light of the more recent developments of physical geodesy rather than in the light of the foundations of this science laid so largely and so effectively by Gauss, Laplace and Poisson a century ago.

Accordingly, the equations of motion of the falling body are established without neglect of any terms which belong to them, and no terms in the integration of these equations are neglected without precise specification of their relative magnitudes. The energy method of Lagrange is followed in establishing the equations of motion, partly because it is specially adapted to the case and partly because it does not appear to have been used for this purpose hitherto. The position of the body is defined by reference to four sets of axes, and the equations of motion for each of three of these sets are derived and integrated so as to include all terms of the second order. These latter depend not only on the square

of the angular velocity of the earth, but on its attraction and on the difference between the geocentric and the geographic latitudes of the point in which a line drawn through the initial position of the body and normal to some plane of reference below pierces this plane. The three sets of equations of motion just referred to are expressed in terms (1) of the polar coordinates of the body (r, ψ, λ), r denoting radius vector from the center of the earth, ψ geocentric latitude and λ longitude from a principal equatorial axis of inertia of the earth; (2) of the rectangular coordinates (ξ, η, ζ), with origin at the point of intersection of that plumb line through the initial position of the body which is perpendicular to the horizontal plane of reference below, with distance ξ measured in this horizontal plane and parallel to the meridian plane through the initial position of the body, positively towards the equator, with distance η positive towards the east and normal to the initial meridian plane, and with distance ζ positive upwards and parallel to the normal at the origin; (3) of the orthogonal coordinates (η, ρ, σ), giving the distance η of the body east of the initial meridian plane, the distance ρ of η from the earth's axis of figure and the distance σ of the body from the plane of the earth's equator. It is thus practicable not only to approach the problem by different routes and to check all steps in the processes of solution, but also to see at once wherein the results reached differ from the conflicting results hitherto published.

Of the three sets of equations of motion, that for the last, or that for the coordinates η, ρ, σ, is the simplest. The integrals of this set (new to the subject, so far as I am aware) give the distance σ to a high order of approximation as a simple harmonic function whose amplitude is the initial value of σ; while the distances η and ρ are given with equal precision by sums respectively of two simple harmonic functions of two different angles. It is remarkable also that the diminution of the radius vector r and the easterly deviation η are each expressed with precision by a single hyperbolic term. In general, the system of coordinates r, ψ, λ is most convenient for the purposes of computation. But the equations for interconversion of all of the sets of coordinates are given in detail in the mathematical paper referred to.

It is shown that the meridional deviation specified by the ordinate ξ is always negative, or that this deviation is always towards the adjacent pole in either hemisphere instead of towards the equator as hitherto supposed. For a fall of 10 seconds, or 490.24 meters (in vacuo), in latitude 45° the meridional deviation would be 3.03 centimeters, and the easterly deviation 16.85 centimeters. These two deviations are proportional approximately to the square and to the cube, respectively, of the time of fall.

My investigation is subject to two voluntary restrictions and to one limitation dependent on our present lack of observational information in geodesy. The first restriction lies in the neglect of the effect of atmospheric resistance on the orbit of the falling body. This effect is known from the work of Laplace, Poisson and others to be very small, since the path of the body throughout its fall is everywhere very nearly normal to the stratification of the air. For such falls as may be practicable for observation this effect is negligible, especially in comparison with the effects of currents of air and of lateral displacement due to the rolling of the smoothest spheres.[3] The other restriction lies in solving the

[3] I consider it quite impracticable to make any conclusive experiments on the deviation of spheres falling in air.

problem of fall for the case in which the orbit is wholly external to the earth. The more complex case of a body falling down a bore-hole, or mine shaft, or the case in which the orbit lies partly without and partly within the earth's crust, is not considered. In view of the difficulties in the way of experimental applications it has not seemed to me worth while to extend the paper so as to include the additions and the modifications essential to these more complex cases.

The limitation referred to arises from insufficient knowledge as to the distribution of the earth's mass in respect to the plane of the equator. For nearly a century it has been generally assumed that this distribution is such as to make the two principal equatorial moments of inertia of the earth equal. In the absence of adequate information on this point I have followed the current assumption, the effect of which in the case of a falling body is to make its orbit independent of longitude. But I do not believe this assumption is justified, and I would take this occasion to urge upon astronomers and geodesists the great need for the settlement of this and other questions in geophysics of a systematic gravimetric survey of the earth. Any inequality in these moments of inertia produces also a necessary prolongation of the Eulerian cycle which figures so prominently in the theory of latitude variations, and it appears to me highly probable that this prolongation is due quite as much to that inequality as to an elastic yielding of the mass of the earth. R. S. WOODWARD

FUNCTIONS AND LIMITATIONS OF THE GOVERNING BOARD[1]

THE development of higher education in America during the past quarter of a century has no parallel in history. In no other country have private citizens lavished upon universities so many millions for equipment and endowment. In no other country have universities received from state or national governments so many millions for maintenance. The annual income of Columbia University is greater than the combined incomes of Oxford with her score of colleges—Oxford with a thousand years behind her, the great national university of England. The University of Illinois, which twenty-five years ago was scarcely the equal in income or equipment of a first class agricultural high school of the present day, has an annual income far greater than that of the great national university of Germany, at Berlin, an income greater than that of the Sorbonne—in short, an income far greater than is claimed for any of the ancient and famous universities of the Old World. More money—one may venture to assert, the figures are not at hand—has been spent upon buildings and equipment for the University of Chicago during the past fifteen years than has been spent upon the buildings and equipment for the University of Bologne throughout its thousand years of history.

But after all, vast endowments and stately halls of granite or marble do not make a university. A real university is the creation of great men. Only in an inspiring environment which lures to it real scholars and thinkers may a great university be created or maintained. The finer spirits of the republic of letters will shun and hate the stifling atmosphere of a university, no matter how vast its endowment or how splendid its buildings, that does not give its professors a feeling of security and of freedom.

Does the American university offer to its teachers such an environment? Some doubtless do, the vast majority unquestion-

[1] Speech delivered (July 9) before the National Educational Association, at Salt Lake City, by Edwin Boone Craighead, LL.D., D.C.L., president of the University of Montana.

ably do not. For reasons not hard to discern, many of our ablest scholars and bravest spirits have come to hate the very atmosphere of the university and are longing to escape from it and to turn their steps toward the big wide world of struggle and strife, where men are at least free to carve out their own destinies in their own way and by their own efforts. In no other civilized country have the great scholars and teachers so little influence in university administration. For many centuries Oxford has in the main been governed and administered by the thinkers and scholars and teachers within her own walls. "Elsewhere throughout the world," says an editorial in *Popular Science Monthly*, "the university is a republic of scholars administered by them—here it is a business corporation." In America the university is governed and unfortunately sometimes actually administered by men whose "life activities lie outside the realm they rule." "The very idea of a university as the home of independent scholars," says Professor Creighton, of Cornell, "has been obscured by the present system." "The disastrous effect of the system," says Professor Jastrow, of the University of Wisconsin, "is blighting the university career." "It is one of the most productive of the several causes," says Professor Ladd, of Yale, "which are working together to bring about the degradation of the professorial office." "If the proper status of the faculties is to be restored, if the proper standard of educational efficiency is to be regained, there must be," declares Professor Stevenson, "a radical change in the relation of the teaching and corporate boards." Says Mr. Munroe, of The Massachusetts Institute: "Unless American college teachers can be assured that they are no longer to be looked upon as mere employees paid to do the bidding of men who, however courteous or however eminent, have not the faculty's professional knowledge of the complicated problems of education, our universities will suffer increasingly from a dearth of strong men, and teaching will remain outside the pale of the really learned professions. The problem is not one of wages; for no university can become rich enough to buy the independence of any man who is really worth purchasing. Young men of power and ambition scorn what should be reckoned the noblest profession, not because that profession condemns them to poverty, but because it dooms them to a sort of servitude." "Whatever organizations may be necessary in a modern university," declared President Schurman, of Cornell, "the institution will not permanently succeed unless the faculty as a group of independent personalities practically control its operations."

These protests are made not merely by sore-headed, dyspeptic men whose principal business in life it is to growl and snarl, but by sober-minded, patriotic men, some of them the great scholars and thinkers of the nation. My own experience as a college executive confirms the opinion that the university career is becoming more and more repulsive to men of real ability. More and more also, our brightest students are turning from the teaching profession to enter the more independent and the more lucrative professions of law, of engineering, of medicine, of farming and of business. More and more students of mediocre ability, the wooden fellows without initiative or courage, are they who, subsisting upon scholarships and fellowships, turn towards the university career and work for the higher degrees. To become a Ph.D. appears to be the sole ambition of large numbers of them who, when the degree is won, seem satisfied to rest upon their laurels throughout the

remaining years of their lives. Of course rare and splendid exceptions there are, but more and more are able young men scorning the teaching profession as fit only for women and effeminate men. It has been humorously said that in the schools of the future, yea even in the universities, real men teachers will not be found except here and there a stuffed specimen in the university museum.

"Professor A," said the president of one of the best southern universities, "is a weak man."

"Of course he is," replied a well-known professor, himself a teacher of thirty years experience. "The very fact that he is a university professor is proof positive that he's a weak man. Nobody but a weak man or a blank fool would be a university professor."

In all earnestness, I may assert that during the past ten years I have talked frankly and sometimes confidentially with scores of able professors concerning the university career, and among them all I have found few men of real ability who have not felt more or less dissatisfied with the profession of teaching. "I love teaching and the work of the investigator," said a distinguished university professor only a few days ago, "but I feel so helpless and so dependent and so much like an hireling in the position I now hold, that I sometimes long to get out of the whole business."

There is something wrong somewhere if conditions such as are depicted even approximately exist. To change these conditions, to make the university an attractive place for great scholars and brave thinkers and lofty souls, and not, as it sometimes is, a stronghold for the politician, the time-server, the coward, the sycophant—that is a work worthy of heroes and statesmen and educators. Big endowments for universities are desirable if not indeed necessary, but big brave men in universities are equally desirable and far more necessary. Only the greatest men of the nation are great enough to teach and inspire the young men of the nation. That nation is greatest which has in proportion to its population the greatest number of real universities, and that university is greatest which gathers to it the largest number of great men. Your really big professor would rather exist on a pittance in a university where he feels free and independent, master of his own soul, than to live luxuriously in a splendidly endowed school, dependent upon the good will or the caprices of politicians and ward bosses, or shivering in fear of offending some multi-millionaire upon whose bounty his university exists.

What, then, is the matter with the university? Scores of able men, whom I much admire, would lay foul hands upon the university president as though he were the cause of our academic slavery. They denounce him as an autocrat and a tyrant who, having seized every prerogative that he did not find nailed down, "holds a Damascus blade over other men's lives, careers, reputations." They would see the "presidential office shorn of its unwise and unsafe authority," of its "limelight conspicuousness," of the "foolish and increasing pomp and circumstance" which usually and increasingly attend presidential installations and, in vulgar eyes, transform wire pullers and gumshoe educators into great men and commanding figures upon the educational horizon. They would reduce his salary to that of an ordinary professor, have him live in a house not bigger nor better than the houses of his colleagues. Indeed there are in our universities able men and otherwise lovely souls to whom the very sight of a university president seems to be, if one may judge them by their words, like the waving of a

red flag to an enraged beast. To them the university president is "the black beast in the academic jungle." They cut him to pieces with their ridicule, they lash him with their wit, they make him ridiculous with a humor that seems inexhaustible.

"I once incited," says the distinguished editor of *Popular Science Monthly* and of SCIENCE, Professor Cattell, of Columbia University,—"I once incited one of my children to call her doll Mr. President, on the esoteric ground that he would lie in any position in which he was placed." The time of the university president, he tells us, is "largely occupied with trying to correct or to explain the mistakes he has made, and the time of the professor is too much taken up with trying to dissuade the president from doing unwise things or in making the best of them after they have been done."

Now, to be perfectly fair to Professor Cattell, it must be admitted that his hatred of university presidents is not against them as men, who, he admits, may be as truthful, honest and kind as the rest of the faculty, but against them as the products of a system that is calculated to produce sycophants, and bosses, and liars. It is doubtless true that some men, possibly many, have become college presidents not because of their merit, but because they are skillful politicians or successful wire-pullers, and it is also true that such men, when once they get into office, usually employ the methods of politicians and bosses. Such men build up a machine, gather around them a body of time-servers loyal to the administration, who also help to create for the real scholars of the university a chilling and forbidding atmosphere. Such presidents soon drive from their universities all the independent and high-spirited professors who can find places in other institutions and make miserable the lives of such professors as are too old to get away or are too ill-starred to find elsewhere an opening suited to their talents and attainments. Professor Cattell is doing a real service in pouring upon such men the contempt and ridicule they deserve. Such executives, whether they are found as principals of normal schools, superintendents of city systems, college heads or university presidents, deserve to be hung for high treason against the great republic of letters and the commonwealth of science. But let us not forget that they are the creatures, not the creators of a system that threatens, unless reformed, to turn over the temples of learning to educational gamblers and money changers, to bosses and politicians, to all the foul and loathsome creatures who, while "cowering to those above them always trample on those beneath them"—I mean the system that places in the hands of an external, irresponsible board the power to govern and to control in minutest details a great seat of learning.

Before I proceed further let me declare as emphatically as may be that the vast majority of trustees whom I have known I esteem as generous and upright men. It is the system, not the individuals that I am attacking. I wish that Professor Cattell could be induced to turn his vast learning to the consideration of this more fundamental question, and to let his illuminating wit play upon it—the question of the governing board of a university. May we not hope that President Pritchett of the Carnegie Foundation may get one of the really great educators of the world, or perhaps a committee of such educators, to write an authoritative bulletin on the functions and the limitations of the governing board, and place it in the hands of every school trustee in the land. This and other good literature bearing on the same subject

should be read by every university regent —indeed before taking oath of office he should perhaps be required to pass, before a committee of the faculty, an examination on the functions and limitations of a governing board. Such a bulletin, if widely read and studied by the great mass of thoughtful people, would do more for the cause of university education than the gift of millions to endowments. Indeed it may be confidently affirmed that the greatest single problem that concerns the American university is the problem of securing competent administrators.

The chief function of a university board is to resign if they find themselves incompetent or unable to do the work entrusted to them. If, however, they consider themselves competent, they should see to it, when vacancies occur, that they be filled by men intelligent enough and high-minded enough and patriotic enough to govern wisely a higher educational institution. Without a board composed of such men, the best endowed private university or the best supported state university is sooner or later likely to become, not a nursery of scholars and scientists and noble spirits, but a stronghold and a retreat of scheming, wire-pulling, snarling, backbiting, cringing, crawling, fawning pinheads and mediocrities and sycophants, bent on cutting the throats and destroying the reputation, of all who stand in their way—men who bear without whining the sting of the lash of their superior officers while administering still more heroic treatment to their own underlings.

The first essential qualification, both of a president and of a professor, is that he be a man, a brave, generous, high-minded man, and the first article in the creed of every real man is that, on the one hand, no matter how great the prizes to be won, he shall not cower to those above him, and, on the other, no matter what power may be placed in his hands, he shall not trample on those beneath him. Are our holy temples of learning to become a nursery of such men or are they to be transformed into what DeQuincey unjustly called the German universities, kennels of curs? It depends upon the governing board and upon the governing board alone.

It is true that back of the governing boards in state universities are the people who create the boards, or, as has happened in more than one state of the union, the people who create the bosses who create the governors who create the boards. In the strictest sense the people in a democracy are the sources of power and upon the people, in the last analysis, must fall whatever of glory or of shame is connected with their university administration. But since it is not possible to hold a whole people responsible we must turn to the men they intrust with authority, the trustees.

What limitation shall be placed upon the governing board? Almost none whatever if it be a good board. As in good colleges no rules whatever governing conduct are imposed upon students except the single injunction that they be gentlemen, so in the ideal university the question of the limitations of the faculty, the president, the board, may scarcely arise because all work for common good. A good board is not necessarily composed of great scholars, of millionaires, of merchant princes, of brilliant statesmen, of mighty potentates in church or state. A board composed of such men would not necessarily be a good board —it might be. A good board like a good tree will bring forth good fruit, and a bad board bad fruit. A good board will not abuse its power. Since, however, under existing conditions bad boards may creep into control, it may be advisable to put limitations upon them. As in monarchies

where bad kings once had unlimited power to inflict injustice and to disturb the lives of men, the people for protection have so hedged him about as to make him almost a figure-head, so it may become necessary in our great universities to put such limitations upon the governing boards that it will not be possible at least for them to do much harm, if indeed they are not wise enough or intelligent enough to do much good.

What, then, is a good board? A good board is composed of a body of men, whether large or small, who have at least two qualifications: (1) plain, old-fashioned honesty and horse sense; (2) technical knowledge, whether acquired in or out of the university, sufficient to call to their service competent experts, and to sift the advice of these experts and, when this is done and only then, to inaugurate right movements and wise policies, and to reach conclusions in the solution of the delicate and difficult problems that continually face such a board. The besetting sin of the university board is that they either do not know how, or, knowing how, are too cowardly, to call to their service the best educational experts. Hopeless beyond any possibility of redemption, the board that does not know that while they may govern, they can not administer, the university. That belongs to the faculty and to the faculty alone. How many American colleges and universities have been injured, if not indeed absolutely ruined, by meddlesome interference on the part of trustees with the work of the faculties, by the taking upon themselves tasks for which they are wholly unfitted, tasks that belong to the faculty. Sad indeed the state of that university whose board removes able professors who have rendered long service, to make places for men not fitted for professorial chairs or, worse still, for political henchmen without either the character or the training that fits them to become instructors of youth.

Many illustrations are at hand. Just before leaving home I had a letter from a well-trained teacher, which, as nearly as I can remember, reads as follows: "I am seeking a position in another school for the same reason that induces forty of our professors and three heads of our state institutions to look for positions elsewhere." In that state politicians on the board and off the board have so long tinkered with the state institutions and so long harassed the professors in them, that good men can endure it no longer except under the compulsion of stern necessity.

Take another illustration. Only a few weeks ago an old friend wrote me as follows: "For God's sake help me if you can. For years I have been harassed to distraction by this ignorant, conceited, crooked board. I am not merely on the brink, I am in the very middle, of hell itself." That man is an educator, an M.A. and a Ph.D. of a great American university.

Take another. Not long ago the president of a well-known state university said to me that he had decided to resign his position, giving as his reason the constant interference of the board in matters that seemed to him to belong to the faculty. He pointed out many instances of this interference. One member of the board, a lawyer and a college graduate, one day tossed before him a big bundle of papers with the remark: "The faculty has been giving a good deal of time to courses of study. I have taken up the matter myself. The other day I went down to my office, took off my coat and worked for four hours preparing a curriculum for each department of the university. Here it is and I expect you to put it through."

"Our colleges," says J. J. Chapman, an

unusually brilliant writer, "have been handled by men whose ideals were as remote from scholarship as the ideals of the New York theater managers are remote from poetry. In the meantime the scholars have been dumb and reticent."

One more illustration. "It falls just beyond my experience," says Professor Jastrow, of the University of Wisconsin, "to have members of the faculty addressed by a member of the board as 'you men whom we hire.' It is within my experience to have professors summoned inquisitorially before a committee of the board to give an account of themselves, the interview conducted by the chairman with his feet on the table, and displaying a salivary agility that needs no further description." Such reminiscences, however, as Professor Jastrow well says, carry no sting. They are merely amusing. Such men are apt to be good fellows, or at any rate, open-minded.

It is really amazing how dependent our universities seem to be upon the legal fraternity. I am making no brief against lawyers—the best board member I have ever known was a lawyer, but he was a big one, a great jurist, a profound scholar—but lawyers as a class are usually the worst men on boards because they love to split hairs, whereas big business men are the best because they are accustomed to do big things.

But to return. What state university president has not encountered some young lawyer, perhaps an alumnus, who has felt it his duty to inaugurate university reform and to match his ignorance of university matters against the combined wisdom of a score of learned professors who have given the best years of their lives to educational problems? It would be a humorous, if indeed it were not so often a tragic, spectacle. As well might we call the mediocre lawyer of a country village to revise the decisions of the Supreme Court and to tell the members of that august body how to transact the nation's business.

What president of long experience has not encountered the nouveau riche, the parvenu who, regarding the impecunious college professors as mere hirelings, as mere dirt and rubbish, undertakes to establish policies to prevent rise of salaries and thereby to place the institution upon a sound financial basis. Sometimes, though rarely, one encounters the business man who, feeling how successfully he had conducted his department store or factory, begins at once to apply factory methods to the delicate and intricate, the high and holy work of a great educational institution. He also regards the teachers as hirelings. Is it any wonder that when university professors find themselves placed in humiliating subjection to men of this stamp they become unhappy, dissatisfied, disgusted even with the university career?

Then there is the small demagogue content with any old job that pays his traveling expenses and gives him an allowance of five dollars a day. He is not necessarily vicious, but only needy. Presidents have had worse men to deal with. A box of cigars, a good dinner, a bag of peanuts, or even a generous slap on the shoulder, may hold in check for a whole day his mighty, all-consuming passion for reform.

But there is another type of men sometimes found on university boards which I can not adequately describe because of the limitations of the English tongue and the refinement and culture of my audience. He is the pinhead. While great men become modest when vested with vast power or supreme authority, the pinhead, although he may be honest, although he will neither lie nor steal, is apt to become the very oracle of wisdom as

soon as he finds himself settled for life on a self-perpetuating board. Low-browed, thick-headed, sometimes the holder of a college degree, now strutting like a peacock, now looking wise as the owl, an indomitable fighter, he baffles the genius and the ingenuity of the ablest executive. The intelligent ward boss or the politician of big dimensions, no matter how crooked, is not quite so bad a man on a university board as the miserable little pinhead who is to me what the president is to Professor Cattell, "the veritable black beast in the academic jungle." No logic, no array of facts, no appeal to educational experts can make the slightest impression upon his small, thick skull. He is firm as adamant, vindictive as the viper, and in constant communion with the Almighty God. When thrown into conflict with such a man there is nothing for the president to do but to hold up his hands and to pray without ceasing that the Giver of all good things may bountifully bestow upon him the saving sense of humor, without which even the ablest university president must find the academic world a cold and cheerless place.

The road that leads out of these deplorable conditions is perhaps a long and rocky road, but we must find it and make our way out to a freer air, a happier environment, or else the very life of the university as an acropolis of culture, as the stronghold of the "great and lonely thinker," as the nursery of noble and heroic souls, is absolutely doomed. University boards can not longer afford to ignore the faculties. In all large questions of university administration, the faculty should have a hearing and a voice. To give to the faculties the control that belongs to them, to create both for students and professors a happier environment, is, after all, the high duty of administrators. I have an abiding faith in the outcome. To all brave souls who are growing weary and faint-hearted, let me commend the words of Carlyle: "It is our duty to do the work that God Almighty has entrusted to us, to stand up and fight for it to the last breath of our lives."

The work of establishing and administering a university calls for the united efforts of faculty and board and alumni, who should work together in mutual trust and esteem for the uprearing of a real university, the most potent instrument that man has yet devised for his own advancement, for the enrichment of his life, for the development and diffusion of knowledge, and for "the enlargement of the boundaries of the human empire to the attainment of all things possible."

Edwin Boone Craighead

INDIAN REMAINS IN MAINE

Early this year, the archeology department of Phillips Academy at Andover sent an expedition to the state of Maine to carry on an exploration of various sites. By the end of August the party had located and mapped some hundred or more shell-heaps and village sites. Forty-eight shell-heaps were found within ten miles of Bar Harbor, and if the circle be extended to fifteen miles, there must be at least 75. Several of these were examined and some hundreds of bone and stone implements taken therefrom.

The coast from below Blue Hill to Bar Harbor (excepting the Castine region) was carefully investigated in the hopes that a "Red Paint People" cemetery might be discovered. But in spite of much searching, no undisturbed site could be located, although disturbed cemeteries were found at Blue Hill and Sullivan Falls and about one hundred stone objects removed therefrom.

The largest shell-heap lay upon Boynton's Point in the town of La Moine. This deposit is more than 200 meters long and 20 to 30 meters in width. It is roughly estimated that

some 7,000,000 clam-shells are in the heap. About 300 articles in bone and stone were taken out of the trenches.

The harpoons collected by the expedition number some 40 or more and are interesting in that they present several types of hafting and barbing. Sections of the shells (in situ) were removed and shipped to Andover in order that a cross section may be exhibited. This will give visitors and students a better idea of the shell-heaps than the usual exhibits of articles removed from such places.

The expedition will end its labors about September 15. Dr. Charles Peabody directed the work, with W. K. Moorehead as curator in charge through the season. Francis Manning, of Harvard, was assistant and Ernest Sugden surveyor. The party numbered twelve or fourteen persons and the work done was extensive.

BONAPARTE RESEARCH FUND GRANTS[1]

THE committee of the Paris Academy of Sciences appointed to consider the distribution of the Bonaparte research fund has made the following recommendations for the year 1913: H. Caillol, 3,000 francs, for the completion of his work entitled "Catalogue des coléoptères de Provence"; A. Colson, 2,000 francs, to enable him to continue his experimental work in physical chemistry; E. Coquidé, 2,000 francs, to assist him in carrying out his study of the turf lands of the north of France from the agricultural point of view; C. Schlegel, 2,000 francs, to enable him to continue his researches on Crustacean development; Jules Welsch, 2,000 francs to assist him in his geological exploration of the coast lines of France and Great Britain, and to extend them to Belgium and Scandinavia; MM. Pitard and Pallary, 6,000 francs, equally divided, for their scientific expedition in Morocco, organized by the Société de Géographie; Louis Roule, 2,000 francs, for the continuation and extension of his researches on the morphology and biology of the salmon in France; M. Pougnet, 2,000 francs, to enable him to continue his researches on the chemical and biological effects of the ultra-violet rays, and for the construction of a quartz apparatus to be used for studying the action of ultra-violet light upon gaseous bodies; M. Dauzère, 2,000 francs, for his work on the cellular vortices of Bénard; M. Gard, 2,000 francs, for the publication of a work and atlas dealing with the material left by the late M. Bornet; M. Chevalier, 4,000 francs, to meet the expenses necessitated by the classification of the botanical material collected in the course of his travels in western and equatorial Africa, and the publication of memoirs on the flora of these regions; Paul Becquerel, 2,000 francs, for the continuation of his physiological researches relating to the influence of radioactive substances on the nutrition, reproduction and variation of some plant species; Le Morvan, 4,000 francs, for the completion of his photographic atlas of the moon; M. Pellegrin, 2,000 francs, to aid him in the pursuit of his researches and to publish his work on African fishes, more particularly those of the French colonies; M. Rengade, 3,000 francs, for his proposed systematic examination of mineral waters for the presence and distribution of the rare alkaline metals; M. Alluaud, 3,000 francs, for facilitating the study and publication of documents collected by M. Jeannel and himself on the alpine flora and fauna of the high mountainous regions of eastern Africa; M. Lormand, 2,000 francs, for the purchase of a sufficient quantity of radium bromide to undertake methodical researches on the action of radioactivity on the development of plants; A. Labbé, 2,000 francs, for the study of the modifications presented by various animals passing from fresh to salt water or the reverse; de Gironcourt, 3,000 francs, for the publication of the results of his scientific expeditions in Morocco and western Africa; M. Legendre, 3,000 francs, to assist him in the publication of the maps and documents dealing with his travels in China; H. Abraham, 2,000 francs, for the determination, with Commandant Ferrie and M. A. Dufour, of the velocity of propagation of the Hertzian waves between Paris and Toulon.

[1] From *Nature*.

SCIENTIFIC NOTES AND NEWS

In honor of Professor John Milne and to continue his work in seismology, it is proposed to collect a fund for endowment. His seismological observatory will probably be moved from the Isle of Wight to Oxford.

The Hanbury medal of the Pharmaceutical Society will be presented to Dr. F. B. Power, director of the Wellcome Research Laboratories, London, on the occasion of the opening of the School of Pharmacy in October, when Dr. Power will give the inaugural address.

Dr. Richard P. Strong, professor of tropical diseases in the Harvard Medical School; Dr. Ernest E. Tyzzer, assistant professor of pathology and director of cancer research at Harvard, and Dr. C. T. Brues, of the Bussey Institution, have returned from the expedition, on which they started on April 30, to study tropical diseases in Peru and Ecuador.

Professor von Noorden has resigned his chair in the University of Vienna and will return to Frankfort.

The council of the University of Leeds has accepted with regret the resignation of Mr. Roberts Beaumont, professor of textile industries, and has placed on record its appreciation of his services lasting over a period of thirty-four years.

Dr. J. L. Prevost has retired from the chair of physiology at Geneva on reaching the limit of age.

Dr. Louise Pearce, of the staff of the Johns Hopkins Hospital, has been appointed assistant to Dr. Simon Flexner, of the Rockefeller Institute for Medical Research. Dr. Franz Knoop, associate professor of physiological chemistry at Freiburg, has declined a call to the institute.

The Glasgow City Corporation has arranged to send on a tour to this country Mr. W. W. Lachie, the engineer of the electricity department, together with the convener of the electricity committee, for the purpose of collecting information regarding the cost and operation of the largest electrical installations of this country.

Dr. Mario Piacenza, the Italian Alpinist, has succeeded in reaching the summit of Mount Numzkum, a peak 22,000 feet high in the Himalayas.

The death is announced, in his fifty-first year, of Professor Edwin Goldmann, honorary professor of surgery at Freiburg.

Dr. C. M. Figueira, long professor of clinical medicine of Lisbon, and one of the few scientific men of Portugal, has died at the age of eighty-four years.

Dr. Carl Basch, of Prague, known for his work in physiology, has died at the age of fifty-four years.

The forty-first annual meeting of the American Public Health Association will be held in Colorado Springs, Colo., from September 9 to 13, under the presidency of Dr. Rudolph Hering, of New York. The work of the association has been divided into the following sections: Laboratory Section, Professor F. P. Gorham, of Providence, R. I., chairman, and Dr. D. L. Harris, of St. Louis, secretary; Section in Vital Statistics, Dr. W. S. Rankin, of Raleigh, N. C., chairman, and Mr. David S. South, of Trenton, N. J., secretary; Section of Public Health Officials, Dr. P. M. Hall, of Minneapolis, chairman, and Dr. E. C. Levy, of Richmond, Va., secretary; Section in Sanitary Engineering, Colonel J. L. Ludlow, of Winston-Salem, chairman, and Dr. H. D. Pease, of New York, secretary; Sociological Section, Mr. Homer Folks, of New York, chairman, and Mr. S. Poulterer Morris, of Denver, secretary.

The international committee, which met in Paris recently to decide upon the place and time of the next meeting of the International Eugenics Congress, has decided to accept the invitation to hold the next congress in New York in 1915, on or about September 20. The American delegates to the recent congress were Dr. Frederick Adams Woods and Dr. David Starr Jordan. The arrangements for organizing the next congress rest with the American delegates and the Eugenics Record office at Cold Spring Harbor, N. Y.

THE exhibition of specimens illustrating the modification of the structure of animals in relation to flight which has been in preparation for many months at the Natural History Museum has, as we learn from *Nature*, been opened to the public. It occupies the fourth bay on the right of the central hall, and comprises 166 mounted objects and twelve microscopic specimens for the purpose of elucidating the subject in a popular manner. The adaptation of each kind of flying animal for aerial locomotion is explained, and the changes that must have taken place in the struture of the body before the animal could really fly are indicated, and attention is directed to the remarkable fact that the power of flight has been evolved independently in different groups of animals—*e. g.*, bats, birds, Pterodactyles and insects.

DR. HENRY GODDARD LEACH, secretary of the American-Scandinavian Foundation, has returned from an official tour of Sweden, Norway and Denmark. The foundation was endowed by the late Niels Poulson, president of the Brooklyn Iron Company, with $600,000 to maintain an interchange of students, teachers and lecturers, and to promote in other ways intellectual relations between this country and Scandinavia. Fellowships have been awarded to two representatives from each of the three countries, and they will enter universities in this country this fall. Plans also have been discussed for an exchange of professors between the University of Copenhagen, the University of Christiania, the University of Upsala and several American institutions. Dr. Leach left New York in May to confer with the advisory committees of the three Scandinavian countries concerning the choice of fellows, who will pursue their studies here. One of those chosen is Ellen Gleditsch, from Norway, who has studied for five years with Mme. Curie in Paris, and will take up her work here in Johns Hopkins University. Her countryman, Arnt Jacobsen, is a student of bridge construction. Denmark is represented by C. M. Pederson, a student of technology, who will enter the Massachusetts Institute of Technology, and Vilhelm Slomann, a student of library methods, who will go to the State Library in Albany. Sweden will send Erik Koersner, a civil engineer, and Einar Corvin, an investigator in experimental psychology.

ACCORDING to a cablegram from New Zealand to the daily papers, relief arrived just in time to save Dr. Douglas Mawson, the Australian Antarctic explorer, and his five companions who were left last March on Macquarie Island in the Antarctic Ocean when the remaining twenty-four members of Dr. Mawson's expedition returned to Tasmania from their South Polar trip. The six men were believed to have ample provisions to last them until the Antarctic spring, but the commander of the government steamer recently sent to their relief reports that the explorers had exhausted all their supplies. Two members of the Mawson expedition—Lieutenant Ninnis, an English army officer, and Dr. Xavier Mertz, a Swiss scientific man, lost their lives in accidents on the ice. The original expedition left Hobart, Tasmania, on December 2, 1911, its principal object being the exploration and survey of the Antarctic coast line. When the *Aurora* went to fetch the explorers back, early this year, the vessel was forced to leave before taking on Dr. Mawson and five of his companions forming one of the parties, as the ship was in danger of being crushed by the ice.

A CONFERENCE on the Binet-Simon tests was arranged by Professor Lewis M. Terman, of Stanford University, to be held at Buffalo on August 29 in connection with the Fourth International Congress of School Hygiene. The special purpose of the conference is to consider matters relating to needed revisions of the scale and to its proper use. The following papers were in the program:

Dr. Henry H. Goddard: "The Reliability of the Binet-Simon Scale."

Dr. Otto Bobertag, of the University of Breslau: "Some Theses regarding the Scientific Management of the Binet Scale."

Dr. F. Kuhlmann: "The Degree of Mental Deficiency in Children as expressed by the Relation of Age to Mental Age."

Professor Josiah Morse: "The Use of the Binet Tests in the Investigation of Racial Heredity."

Professor W. H. Pyle: "The Value to be Derived from giving Intelligence Tests to all School Children."

Dr. Charles Scott Berry: "Some Limitations of the Binet Tests of Intelligence."

Dr. Carrie R. Squire: "Some Requirements of Graded Mental Tests."

Dr. Grace M. Fernald: "Impressions gained by the Use of the Binet-Simon Tests with Delinquent Children."

Dr. E. A. Doll: "Suggestions on the Extension of the Binet Scale."

Professor J. E. W. Wallin: "Current Misconceptions in Regard to the Functions of Binet Testing and of Amateur Psychological Testers."

Professor Lewis M. Terman: "Revisions of the Binet Scale."

Professor G. M. Whipple: Title of paper to be announced.

THE 67th report of the British Commissioners in Lunacy, as abstracted in the London *Times*, states that the number of notified insane persons under care in England and Wales on January 1, 1913, was 138,377, an increase during the year of 2,716, which is 275 above that of the annual average of the last ten years and 257 above that for the last five years. The private patients under care on January 1, 1913, numbered 11,353 (males, 4,852; females, 6,501). The pauper patients were 125,841 (males, 58,508; females, 67,333), or 90.9 per cent. of all the reported insane. The criminal patients numbered 1,183 (males, 903; females, 280). Since 1898 numerical record has been kept of the first admissions. In that year they were at the rate of 4.92 per 10,000 of the population, and in 1912 the figure was 5.12, a higher figure than obtained in either of the three preceding years, but below the average rate (5.2) during the last decade. The proportion which such cases bore to the total admissions in the last year was 83.5 per cent., which implies that, for every 100 admitted, between 16 and 17 had been previously under care—a proportion which is rather below the average. On January 1, 1912, there were under detention 108,973 persons, and 22,432 were admitted during the year, making a total of 131,405. Of these 7,345 were discharged as "recovered," 2,182 were discharged as "not recovered," 10,353 died and 111,525 remained. On the subject of treatment the commissioners say it would seem to be needful to turn from the therapeutic side to the preventive, if insanity is to be effectively controlled; or rather that, whilst retaining and improving the former class of measures, more ample consideration should be given to the latter. The condition precedent for this is a fuller knowledge of causation to be gained by the prosecution of scientific research.

THE exhibited collection of Mesozoic crocodiles in the geological department of the British Museum (Natural History) has been rearranged, as we learn from *Nature*, to incorporate some important recent acquisitions. A new specimen of *Mystriosaurus* from the Upper Lias of Würtemberg, prepared by Mr. B. Hauff, is one of the finest known examples, with almost complete limbs. The stomach contents are seen, mingled with swallowed pebbles. A specimen of *Geosaurus*, from the Lithographic Stone of Bavaria, shows for the first time the triangular tail-fin by which this essentially marine crocodile propelled itself. The unique example of the Wealden river crocodile *Goniopholis*, discovered a few years ago by Mr. R. W. Hooley in the cliff near Atherfield, Isle of Wight, and described by him in the Geological Society's *Journal*, has also been mounted and exhibited.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of $71,000, being all but $5,000 of the estate of the late Dean Mary Coes of Radcliffe College, is left to the college.

ALTHOUGH the buildings which comprise the complete group of the new Manitoba Agricultural College, that will cost $5,000,000, will not be completed for two or three years, sufficient progress has been made to allow the college to commence moving equipment into the buildings already completed. The site on the bend of the Red River, a few miles south of Winnipeg, contains 1,100 acres.

THE Mobile City Hospital is being enlarged by a new building containing four wards, at a cost of $50,000. It will give accommodation to eighty additional patients, as well as provide suitable quarters for the out-patient de-

partment, new X-ray laboratory, pathological rooms, etc. Medical control of the hospital is entirely in the hands of the faculty of the School of Medicine of the University of Alabama.

AT a recent meeting of the New Mexico Board of Medical Examiners a rule was adopted that hereafter diplomas granted by colleges listed in class C by the Council on Medical Education of the American Medical Association will not be recognized by that board.

UNDER the law of Missouri, the State University receives an inheritance tax of five per cent. on all legacies, except those to direct heirs. The university has brought suit to recover this percentage on the part of Joseph Pullitzer's estate represented by the *St. Louis Despatch* and bequeathed to Columbia University and other institutions.

ELMER A. HOLBROOK, professor of mining engineering in the Nova Scotia Technical College, Halifax, Nova Scotia, has been appointed assistant professor of mining engineering at the University of Illinois, to have charge of the recently equipped coal-washing and ore-dressing laboratory and the course in mine design.

PROFESSOR LEWIS E. YOUNG, who for the past six years has been director of the Missouri School of Mines, will in September take up graduate work in the department of economics at the University of Illinois, and will also give part of his time to teaching in the department of mining engineering.

DR. W. C. MCC. LEWIS, having been appointed to the chair of physical chemistry in the University of Liverpool, has resigned his office in connection with the department of chemistry at University College, London.

DR. OTTO WILCKENS, associate professor of geology at Jena, has been called to Strassburg, to succeed Professor Holzapfel.

DISCUSSION AND CORRESPONDENCE

AGRICULTURAL EXTENSION

IN the June, 1912, number of the *Experiment Station Record* (Vol. XXVI., No. 8) is an editorial dealing with several methods for disseminating agricultural information. An exceedingly interesting part of this editorial is the review of a paper on "Organization and Administration of Extension Teaching in Agriculture" by the director of the federal Office of Experiment Stations.

The writer need hardly assume to write any critical review of statements made by Director True. In view, however, of conditions which exist in various places throughout the country, it may be proper to say that certain statements made by Director True ought not only to be read, but also reread, because they are fundamental. Properly adopted and made part of our educational systems, they will make for progress and avoid not only confusion, but ofttimes unnecessary strife. These fundamental principles for agricultural extension in the several states which seem to be stated in the editorial referred to, are as follows:

1. Considered as an essential feature of the American system of agricultural education, it was held to be primarily the business of the state to create and maintain the institutions through which extension teaching in agriculture shall be conducted. Since it is an educational enterprise, it will naturally be carried on by educational institutions rather than by administrative departments. The nation and state departments of agriculture may both properly aid in this work, but the chief burden of responsibility for it in the several states will naturally fall on the agricultural colleges.

2. Since it is highly important that the information on any subject given to the students and public should represent the views of the institution as a whole, all the experimenters, teachers and extension workers should be grouped by departments representing the specialties in which they are working. Thus the department of agronomy should embrace all the agronomists employed by the college, whether they are engaged in experimenting, teaching or extension work.

These two basic principles, namely, that *it is a function of the state to educate the people of the state* and that *given lines of work in any organization must be administered as a unit*, ought to be clear enough. However, a somewhat limited observation would lead one

to believe that one or both of them are forgotten in some instances and that the forgetting of them leads to little short of disaster.

The writer is interested in the problem of agricultural extension, not in an executive, but in a departmental way. It is this interest which every department, and every member of every department, must take in the ultimate success of the projects which the department represents, that may serve as an excuse, if any be needed, for the present article.

The writer knows, or thinks he knows, from observation, that the practical administration of the agricultural extension idea may be, on the one hand, exceedingly helpful, or, on the other, quite disastrous to any department. In order that harmony of administration shall prevail, "the department of agronomy should embrace all the agronomists employed by the college, whether they are engaged in experimenting, teaching or extension work." The quotation may of course be extended to include all departments of any agricultural college. Every department of every agricultural college should have a head or chief, and he should be responsible for all the work and all the time of all people in the college-experiment-station-extension department who are engaged in the line of work which he represents.

Such a statement may sound dictatorial. It is not. It is only good administration.

So great a movement upon the part of the collective agricultural colleges as the one necessitated by the present demand for public-service or "extension" is bound to carry them back, or perhaps forward, to fundamentals. What is the logic of college "departments"? Answer, college departments logically grow out of natural lines of cleavage between the several portions of work before the college organization. Such lines of cleavage do not naturally intersect, and if they are permitted or forced to do so, the result is confusion. The lines of distinction between the natural departments of agricultural work are clear enough. Animal husbandry, agronomy, horticulture and so on can hardly trespass upon the work of one another, because each division of work grows out of fundamental differences. If the natural divisions of labor, as a result of which departments are created, are kept very clearly in mind by organizations, in "extending" their work, the problem appears not very complex.

Such a statement naturally leads to the inference that the several departments of the college are sovereign within themselves, except for the general executive authority which emanates from the office of the dean or president, and as a corollary it would be expected that all representatives of a given line of work should at all times report directly to the chief of the department and not, for instance, directly to the director of extension. That is also exactly so. "No man can serve two masters: for either he will hate the one, and love the other, or else he will hold to the one and despise the other."

In what relation, then, is agricultural extension in the several agricultural colleges to be administered? In attempting to answer the question, the writer makes bold, very bold, perhaps, to insert the following plan of an ideal administrative arrangement of the departments of an agricultural-college-experiment-station organization.

It may be apparent from this ideal arrangement that the office of the dean and director is the central administrative authority of the entire college. In case of the smaller colleges where the dean assumes the title of president, there is no essential difference. The dean and director not only administers the institution, but he reflects the spirit of the institution. He represents the state in which his college is located in the specialty which his college represents. He is big enough and broad enough and sympathetic enough and democratic enough to provide ways through which all the departments of his organization may independently each attain its highest efficiency. The efficiency of the executive office is not only measured by the efficiency of the several departments which report to it, but also by the ability of the dean and director to transform such efficiency and make it available to the state.

Obviously the departments of any agricultural-college-experiment-station organization are divided according to the work to be specialized in by each department. Obviously also the number of departments will vary according to the financial resources of the institution and the degree of specialization. The number of departments will usually increase as the institution grows older and stronger.

The work of each department shall be directed by the head of that department and he shall accomplish, through the aid of assistants of various ranks, all the work within the field of the department. Assistants in any department may be of any desired rank, and it may well be understood that they are subordinate to the head of the department only as a matter of administrative convenience.

Up to recent times, two distinct lines of work have been recognized as coming within the function of agricultural colleges, namely, research and teaching. Moreover, up to recent times, the teaching in the agricultural colleges has been confined mainly to ordinary instruction in college classes. Of late years it is becoming more and more evident that this is not sufficient. It is not necessary here to review the various means by which the teaching work of the colleges is being and must be carried beyond the classrooms proper.

It is necessary to emphasize that wherever this extension teaching is carried, it must still be teaching, and that it differs only somewhat in place and method from any other teaching. Whether it is classroom teaching or extension teaching is absolutely the same so far as administration is concerned. The same departments which do one kind of teaching must finish their duty. The same departments which do research work and carry the results into the classroom by the process of teaching, must finish their duty and carry the results along with other accumulated data directly to the state at large. Whether a department shall disseminate information by having students come to its classrooms or whether it shall extend itself by going to the four corners of the state, does not change the department, except perhaps in number of assistants and specialists who will be necessary to accomplish the increased work.

If all this be true, what is the logical relation of the extension department and what is the need therefor?

The later-day call for extension "departments" in agricultural colleges has grown out of the insistent demand that the agricultural colleges shall actually serve the state. Extension departments are, therefore, evidences of our growing democracy, crude and ungainly as that may often seem.

Logically, the extension department of any college includes all movements, inaugurated by the dean and director, to extend the work of his organization into the state. The dean and director may be his own extension man, that is, he may personally direct the work of disseminating information from his institution. If due to lack of time or inclination, he extends the work of his institution through the medium of a superintendent of extension, the case is not altered. The superintendent or secretary of extension, if there be one, must logically function as an assistant to the dean and director.

The authority of the superintendent of extension is whatever authority is given him by the dean of the college, whose assistant he is. He should have no power to usurp the authority of any of the heads of departments, nor does he have control over any of the work or any of the time of assistants in any of the departments, for if he has such authority, he will be a general nuisance around all departments, which means around the entire institution and the entire state. If he is strong enough in personality, he will disrupt the entire organization.

The logical work of the superintendent of extension is to assist the dean in collecting and disseminating agricultural information. His usefulness in the institution will be measured by his ability to do this to the fullest extent harmoniously. In detail, his work would naturally include such matters as the arrangement of meetings throughout his state, and to secure speakers from the college to

attend these meetings. In order to arrange for these speakers, he must of necessity confer with the heads of the several departments and have them delegate one or more of their assistants to do such work at specified times. It will be expected that the heads of departments will delegate such speakers unless it is absolutely impossible to do so on account of lack of help. If any given department is constantly unable to furnish teachers for extension work, either a lack of ability or a lack of desire upon the part of the department is indicated and the department should either have more assistance to strengthen it or it should be otherwise helped by executive action. Thus the superintendent of extension shall have a very strong moral influence delegated to him by the dean and director in persuading departments to do every reasonable amount of extension work, but he should not have any absolute authority to go into a department and disorganize it.

By this same token, the superintendent of extension should be an arm of the executive office and not a department head.

There should be no department of college extension in the same sense as there are other departments based upon natural division of labor. The function of extension is to extend the work of collective departments and not in itself to be a department. If it is allowed to be a department, it can only do so by either duplicating a part of the essential work of other departments or by usurping the same, and again it becomes a private and public nuisance.

There are colleges of agriculture in the United States, which if named would at once be recognized as in many respects the strongest in all the country in which the superintendent of college extension is virtually an assistant to the dean and not head of a coordinate department. Two of these greatest agricultural colleges which the writer has in mind have offices of college extension that are seldom talked about, but the colleges themselves are talked about and the work they do in their respective states is also talked about. The writer can think of other colleges where there are separate departments of college extension. The college-extension departments are very much talked about. The colleges they are supposed to represent are not so much talked about.

As time goes on the personnel of departments and their assistants and executives and all understand that they are servants of democracy. When that time, which is rapidly approaching, is completely here, no college or experiment station will rest content without putting its useful and usable information as rapidly as possible into the hands and hearts and heads of the people where it belongs. This latter work may be accomplished in the doing by an office of agricultural extension, but said office will not function like an extraneous department pasted on over other departments like a porous plaster.

A. N. Hume

South Dakota State College,
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A NEW ATTACHMENT FOR THE HARVARD KYMOGRAPHION

Certain methods have been used for studying the effect of fatigue on the muscle curve. Among these there is the old method of recording a make or break contraction; this method consists of removing the writing point from the drum and stimulating the muscle a certain number of times, say nine. The drum is revolved a few millimeters with the hand, then the writing point is replaced against the drum. This is repeated regularly at every tenth contraction until the muscle ceases to respond. This gives a series of straight lines on the drum formed by every tenth contraction of the muscle. The height of these lines gradually decreases as fatigue comes on until the zero point is reached; but it does not tell of the important changes occurring in the latent period and the period of relaxation.

This has been overcome on those particular types of European and American kymographions which have the supporting frame for the drum external. On these types of machines an insulated copper wire may be led

direct from the dry cell and wound around the rod or arm supporting the top of the drum, bent so that the short, bare, free end is directed downward. Now a second copper wire may be led from the opposite pole of the cell to the simple key and connections made from it with other wires via the inductorium to some basilar portion of the instrument. Next, a clean copper wire may be twisted or clamped to some part of the top of the revolving drum and properly adjusted in such a way that, if contact is just barely made with the first wire the circuit will be completed for an instant and the desired stimulus to the muscle will be given at certain definite intervals, always at exactly the same time on a uniform moving drum. In other words, the circuit is through the instrument and its action becomes automatic. In the case of the Harvard kymographion such an arrangement can not be used, for inasmuch as the drum is held by a spring to the sleeve which in turn fits over a tall vertical rod with its base resting on the friction plate there is no external support of the drum for attaching the wires.

Accordingly, in order to produce such automatic action on this particular type of machine, it is evident that some other device must be used. The one which has been worked out by the writer has been very successfully used at the laboratory of the University of Maryland during the past year. It consists of a thin metal disk of about 18 mm. diameter with a central opening large enough to admit the screw of the spin-screw and is held in place by means of the spin-nut against the head of the sleeve of the kymographion. To the outer under edge of this disk are soldered four copper wires of two thirds mm. diameter and about four cm. in length, which radiate out horizontally from the flat under surface of the disk and revolve with the drum. The circuit is then made complete by leading wires of two thirds mm. diameter; one series from the cell, first to the simple key and inductorium, then to the milled head, or some other basilar portion of the instrument; and the other to a tall iron-stand where the insulated wire may be wound around the upper portion of the upright rod, in order to hold it in place with about 6 or 7 cm. of the free end projecting laterally from it and vertical to the rod. Just enough of the insulation is removed from the far end of the wire to make a small eye about 3 mm. in length and 2 mm. in width, and bent so that the loop is directed downward. Into this is placed a wire pendulum made from the same kind of wire (uninsulated) having a similar sized eye at one end and being 5 to 6 mm. in length. When properly adjusted this wire arm projects out over the top of the drum of the kymographion, so that the wire pendulum just barely touches the outer extremities of the radiating arms as they come from the disk and revolve with the drum, thus making the electrical contact for just an instant, and thereby stimulating the muscle automatically.

It is of the utmost importance that the eye in the end of the wire and also the pendulum and ends of the radiating wires from the disk be kept clean and bright by means of emory paper, so that the electrical contact may always be at its highest point of efficiency. I might also mention the fact, that, if the pendulum is allowed to drag itself over the radiating arms by being too long, it will usually have a bouncing movement making several contacts and giving as many stimuli to the muscle.

It is also of advantage, although not absolutely necessary, to use a second simple key between the wire containing the pendulum and the cell, so that the circuit may be broken without stopping the instrument, or moving it away. However, one simple key in the circuit is usually sufficient.

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ACCURACY IN STATING THE OCCURRENCE OF SPECIES

TO THE EDITOR OF SCIENCE: The difficulties of exact scientific expression pointed out by Mr. J. D. Kusen[1] relate to the loose use of certain words in attempting to describe the

[1] SCIENCE, Vol. XXXV., June 14, 1912, pp. 930, 931.

comparative abundance or rarity of certain species of birds in a given locality, at a given time. There are two methods of meeting this difficulty, neither of which will probably meet the approval of every one. The former of these, which will be outlined later, has grown into general use and with a reasonable exercise of common sense in judging the relative occurrences of the species, with due regard to season, meets most requirements.

The latter method will dispense with the sometimes indiscriminate and loose use of adjectives and adverbs such as "very rare," "rather common," etc., and the substitution of a system suggested, I believe some decades ago, by the late Joshua Billings. This system under proper use and a full study of any given locality will express, with mathematical accuracy, all gradations of the occurrence of any species, not only of birds but of the entire range of the vegetable and animal kingdoms.

In this system, the absolute zero and maximum occurrence of any species would be represented by exact expressions indicating accurately the abundance or rarity of a given species. The scales of abundance and rarity would cross or intersect at the gradation now vaguely expressed by the word "common," and their use would entirely dispense with any doubt as to its meaning, and also with such expressions as "very common," "not uncommon," "rather rare" and the like. Mr. Billings's system would express the superlative of abundance, like blackbirds in a tree in spring or the hairs on a dog's back, by *abundance 100;* grading down numerically to *abundance 0,* which would cover the case of no blackbirds at all or the degree of hairiness presented by a billiard ball. *Rarity 0* would express the entire absence of a given species, while *rarity 100* would express an approach to abundance which need not necessarily be noted in the terms of the rarity scale at all.

It will be noted at once that abundance 50 = rarity 50, and that any degree of accuracy can be secured by the decimal system thus:

Myiarchus Crinetus, abundance 67.3; or *Virco Philadelphicus,* rarity 2.7. An obvious advantage of this system is that it will cultivate close and systematic study coupled with accuracy in the expression of results, but they are both subject to serious interruptions by the habits of migration and breeding which vary the occurrence of all species to such an extent as to necessitate commencing the work over again before it could be satisfactorily completed. This, however, is not without its advantages, particularly if those who undertake to alter or direct the use and development of our language by juggling with its synonymous terms could be set at putting the system in use. But for the great mass of English-speaking scientists in search of the clearest mode of describing the things they see and of setting forth the thoughts they have, good Anglo-Saxon well understood and properly used is a strong and flexible medium.

Marsden Manson

San Francisco, Cal.

"QUITE A FEW"

To the Editor of Science: I have just read with much interest the illuminating paper by Professor H. L. Bolley, of the North Dakota Agricultural College, in Science of July 11, with the caption "The Complexity of the Microorganic Population of the Soil."

The writer is however somewhat puzzled to know just what is meant by an expression used by Professor Bolley, in its relation to the commonly accepted standard of what is called "good English." The expression referred to is "quite a few," introduced in the following sentence: "So now, there seems to be quite a few who think they can tell a productive soil," etc.

The puzzle is, to apprehend just what Professor Bolley means by "quite a few." We can well understand that the expression "a few" means a very small number of units; and in the formula "quite a few" there would seem to be an emphasis placed on the "few" by the qualifying adverb "quite." So that in an analysis of the formula the conclusion must be that "quite a few" means a less number of units than "a few."

Is that the idea that Professor Bolley intended to convey, that the number of persons referred to by him in this connection is less than "a few"? Or does he mean more than "a few"; or exactly as many as "a few"?

This array of logical discussion is of course mere quibbling, and is designed to bring out the writer's surprise, that a learned teacher, in a scientific disquisition in a scientific journal, should have introduced this slangy and meaningless expression, that has appeared of late years as a malevolent fungus growth on our "mother tongue," and become a sort of fad much affected by the "light weights" of our present social and literary world.

With apologies to all concerned.

T. G. DABNEY

CLARKSDALE, MISS.,
July 17, 1913

SCIENTIFIC BOOKS

The Fitness of the Environment. An Inquiry into the Biological Significance of the Properties of Matter. By LAWRENCE J. HENDERSON, Assistant Professor of Biological Chemistry in Harvard University. New York, The Macmillan Company. 1913.

This book is essentially a discussion of the nature and implications of organic adaptation, *i. e.*, of the relations between the living organism and the environment, but is written from an unusual point of view.

> Darwinian fitness is compounded of a mutual relationship between the organism and the environment. Of this, fitness of environment is quite as essential a component as the fitness which arises in the process of organic evolution; and in fundamental characteristics the actual environment is the fittest possible abode of life. Such is the thesis which the present volume seeks to establish.

This quotation from the preface defines clearly the author's general purpose and indicates broadly the general nature of his treatment. In his discussion he inverts the order of procedure customary with biologists. Adaptation, he points out, is a reciprocal relation, depending quite as much on the existence of special conditions in the environment as in the organism. This environment—nature, or the physical cosmos—exhibits in its ultimate constitution certain characteristics which are of such a kind as to favor the production and continued or stable existence of living systems or organisms. The world, in other words, is, and was from the beginning, fitted for the abode of life. This was the contention of Paley and the other natural theologians. It implies a biocentric conception of nature—a conception once familiar and, indeed, historically the first to be formed, but which has fallen into disrepute since the rise of the theory of evolution. Dr. Henderson aims at rehabilitating this view and supporting it by an appeal to the results of modern physical science. His conception of nature has thus some of the characteristics of Paleyism in a modernized form, but is essentially uncolored by theological and philosophical prepossessions. The greater part of the book is devoted to an account of the chief physico-chemical peculiarities of the environment. This is largely a description of the general properties of matter, with especial regard to their biological fitness. Attention is called to many conditions favorable to the production and continued existence of living beings. Carbon, hydrogen and oxygen, the most abundant and widely distributed of the elements, and their chief compounds, particularly water and carbon dioxide, possess a variety of properties and modes of behavior which render them ideally adapted to the formation of systems having the characteristics that we call vital. What is insisted on as remarkable is not merely the existence—in such a substance as water—of single properties that are biologically favorable; it is the possession of a unique *combination* of characteristics shown by no other substance, and which so far as we can see could not possibly be possessed by any other substance, that gives water its unique fitness as a component of living matter. Similarly, with carbon dioxide and the other chief compounds of carbon with hydrogen and oxygen: they are uniquely favorable as constituents of protoplasm and no substitutes are conceivable.

In support of these contentions, the author proceeds as follows: He first reviews

the distinguishing characteristics of the living organism. All organisms are primarily complex, *i. e.*, the number of distinguishable structural and functional components is large; they are the seat of continued chemical change involving constant interchange of matter and energy with the environment—in a word, of metabolism; and they exhibit durability or stability in an environment more or less subject to change; in other words, the possession of an automatic power of adjustment to changing conditions, or of *regulation*, is typically highly developed. Complexity, regulation and an energy-yielding metabolism are thus essential to organisms. The question is then asked: "To what extent do the characteristics of matter and energy and the cosmic processes favor the existence of mechanisms which must be complex, highly regulated, and provided with suitable matter and energy as food?"

By a process of elimination the author defines water and carbon dioxide as those constituents of the environment which are most essential to life. The physico-chemical peculiarities of these two substances are then considered at length. The remarkable solvent, thermal and dielectric properties of water are shown to be indispensable to the complexity and stability of living protoplasm; the importance of its chemical properties, especially its ionizing and hydrolyzing action, is also dwelt upon. Similarly, the many remarkable properties of carbon dioxide are pointed out, in particular, its high solubility—a necessary condition for enabling organisms to utilize it in such large quantity—and its dissociation-constant, which has just the value that is most favorable to the preservation of an approximate neutrality in aqueous solutions containing its salts: protoplasm is thus protected against wide variation in its hydrogen-ion concentration; the constancy of reaction thus secured is a highly important factor in securing constancy of chemical conditions in cells, and hence in furnishing the conditions for a stable chemical organization. Other important constituents of the environment are salts: the abundance and variety of these in sea-water are pointed out, and their importance in vital processes—depending largely on their characteristic relations to the colloids—is emphasized. Water, carbon dioxide and salts are thus the essential constituents of the environment of living organisms, and it is ultimately from these substances that the living matter is synthesized. In correspondence with the importance assigned to these substances, special chapters are devoted to water, carbon dioxide and the ocean. The properties of substances in a state of solution are also discussed (osmotic pressure, diffusion, ionization). The following chapter reviews the chief features in the chemical behavior of the three chief elements and their compounds. The author insists that carbon alone, of all the elements, has the properties which render possible the formation of compounds sufficient in number, kind and complexity for vital processes. He also calls especial attention to the *mobility* of carbon—due to the gaseous nature and high solubility of its oxide—and to the importance of the high heat combustion of carbon and hydrogen and their compounds in the energetics of vital processes. By simple reduction, followed by polymerization, carbonic acid passes over into the sugars; and thus the first step from the simple gaseous oxide to complex organic substances, which at the same time are reservoirs of energy, is remarkably simple and direct. The close chemical affiliations of the sugars to many other compounds important to the organism are also briefly discussed. This part of the book is itself a concise summary and hence can not be satisfactorily summarized. The author's essential conclusion is that the foregoing characteristics of carbon, hydrogen and oxygen, which make possible the production of living protoplasm, constitute a series of maxima—are unique when compared with the corresponding properties of other elements. Hence they show the greatest possible fitness for life.

In Chapter 7 the argument is restated in more concise form, and in the final chapter, "Life and the Cosmos," the possible significance of living beings in the whole scheme of nature is considered. How comes it that the

unique properties of carbon, hydrogen and oxygen should be so favorable to the organic mechanism? should fit the universe for life? Are cosmic and biological evolution one? Is there a teleology inherent in nature? There follows a brief discussion of vitalism. The views of Driesch and Bergson, which postulate a physical indeterminism in the organism—*i.e.*, maintain that guiding or activating factors other than physico-chemical intervene in life—are rejected. There is no evidence of gaps in the organic nexus. Yet the possibility of a vitalistic point of view, which is nevertheless consistent with a belief in the entire adequacy of physico-chemical analysis, is not thus excluded, and the author insists that this possibility must be recognized. Cosmic and biological evolution *may* be one. There remains as consistent and possible a teleological view, not of life alone, but of the whole cosmos and thus of life considered as a part or product of the cosmic process. The universe may after all be biocentric. It is not to be expected that scientific research will ever find any instances of complete discontinuity or indeterminism in nature, as the eloquent paragraph quoted from Royce rightly insists; all single events are rigidly determined; but the existence and characteristics of the natural process as a totality, including life as one outcome of this process, are not to be accounted for by purely scientific methods of explanation. A teleological and, by implication, a vitalistic interpretation of nature thus becomes possible. The philosophical questions thus raised are not, however, discussed in detail.

Such is an outline of this interesting, clearly written and thoughtful book. The author's style shows precision and definiteness throughout, and his treatment is clear and consecutive. The account of physico-chemical factors and processes is modern and accurate.[1] In so condensed a book it is easy to point out omissions. More space might well have been devoted to a consideration of the rôle of nitrogen in organisms; this element is fully as important as carbon, hydrogen or oxygen. The chapter on organic chemistry is probably too concise to be popularly intelligible. The section on sugars is perhaps over-technical and its concluding paragraphs are not very clearly expressed. Little space is given to proteins. The difficulties of popular presentation become almost insuperable here, and the author seems to hurry over this part of the task.

It remains to consider critically the general argument of the book. The author transfers the conception of fitness from the organism to the inorganic environment in order to emphasize the reciprocal character of biological adaptation. He then devotes almost his entire space to showing that the environment possesses characteristics favorable to life as we find it. Having shown this, he omits considering in corresponding detail the characteristics of the organism itself, and the general nature of the inter-relations between organisms and environment—in other words, what adaptation itself is, as a general condition or process; and this method of treatment gives a certain impression of incompleteness. Now it is quite clear that the universe must show itself, on examination, to be a fit environment for living beings, since they continue to exist in it; further, this fitness must show itself maximal in the case of organisms showing maximal adaptation to their surroundings; and thus the general outcome of the author's argument might have been foreseen. Granted that systems having the properties of living beings could not have arisen had the properties of carbon, hydrogen and oxygen, and of their combinations, been other than they are, what does this prove? Most biologists will probably consider the author's central thesis as either self-evident or inherently unprovable,[2] and will prefer to regard this book as essentially a scientific essay on the biological importance of the more general and

[1] On page 177 osmotic pressure is said to be proportional to the total number of particles (molecules *plus* ions) which are present in solution, instead of in unit volume of solution, but such inadvertencies are rare.

[2] That is, this world may be the best possible environment for the organisms that have come to exist in it, but it might not be so for the living beings of another and quite different cosmos!

elementary properties of the elements and compounds entering into the formation of protoplasm. Considered in this light alone, the book is remarkable for the breadth and ingenuity of its treatment and for calling attention to many facts and principles the importance of which is often overlooked. To many readers this will constitute its chief interest.

This, however, is not exactly the reviewer's opinion. The question of the final significance of biological adaptations is raised in a novel and interesting form, and some further discussion of this question seems called for here. What, after all, is meant by this conception of adaptation? Considered from the most general point of view, it seems best to regard adaptation as essentially an instance of *equilibrium,* though of a complex kind.[3] Equilibrium is a conception of physical science, and as such susceptible of exact definition; to regard adaptation in this light implies that the problems which it presents are essentially physiological in their nature, and hence relegates the teleological point of view to the background. This is always advantageous for physical science, however it may be for practical life or philosophy. To many, the statement that adaptation is an equilibrium may seem either metaphorical or a truism; to the physiologist it embodies a definite conception of the organism as a physico-chemical system which maintains its existence by a continued succession of automatic compensations. What we observe is that the adult organism preserves its characteristics intact, for a greater or less period of time, in spite of continual loss of material and energy to the environment. Now, the processes by which this loss is balanced by a corresponding intake, thus enabling the life-processes to continue, are just those which we characterize as "adaptive." The structural and functional adjustments necessary to maintain this balance are often delicate and complex in the higher organisms; they involve the existence of special mechanisms—such as the hand, the eye and many others; but these always correspond to certain constant features of the environment, and play a part which in the last analysis is essentially compensatory in the above sense. To put the matter in somewhat different and more general terms: if the characteristics of a system undergoing perpetual change of composition and loss of energy are to be maintained constant, it is indispensable that a set of processes antagonistic to and therefore compensatory to these changes should be maintained. The adaptive and regulatory, and most of the "purposive" activities of an organism form the conditions necessary to the existence of these compensatory processes. Evidently, this point of view implies a fitness in the environment as well as in the organism. The two must correspond as lock to key—or as the oppositely directed and mutually equilibrating components of *any* system in equilibrium—if any such interaction is to be possible. Hence the continued existence of any organism implies environmental fitness, *i. e.,* the existence of conditions and processes in the environment which correspond to or balance those in the organism. It is thus inevitable, if we consider the special peculiarities of any complex and stable system, and correlate them with those of the environment, that the latter should be found to exhibit a "point for point" and reciprocal correspondence with the former. The case of the organism has seemed exceptional simply because biological students have been so long accustomed to regard the organism as a system possessing unique "vital" properties and existing in an environment having totally distinct characteristics. To the human mind there is no more profound contrast than that between living and lifeless. Dr. Henderson's study shows that even in its ultimate constitution the environment possesses characters corresponding to those of the living organism, and the discovery of this truth will no doubt surprise many others, just as it surprised him. But what if this were not the case? Obviously, such systems as organisms could never have come into existence. The surviving organic forms are simply

[3] Adaptation is treated from this point of view in Paul Jensen's "Organische Zweckmässigkeit, Entwicklung und Vererbung vom Standpunkte der Physiologie," Jena, 1907.

those which can maintain an equilibrium with their environment. Of course conditions may arise which disturb this equilibrium. If, then, the organism possesses insufficient power of compensating these new conditions, it sooner or later ceases to exist. Natural selection is simply the process by which such imperfectly compensated living systems are eliminated. The conception of a selective agency as operative in this process of adapting organisms to environment is frankly anthropomorphic, and hence from the standpoint of physical science insufficiently exact. It is better to replace it by a conception in which the organism is regarded as a material system maintaining a dynamic equilibrium[4] with the environment. That the environment should have the character of fitness—that its processes should equilibrate those of the organism—is not surprising, is indeed self-evident. One chief aim of biological science, in fact, is to show how the characteristics of the organism are related to, and ultimately proceed from, those of the environment.

The task of biological science is thus left where we found it. To account for the characteristics of organisms on the basis of the physico-chemical characteristics of their component elements and compounds involves showing how the characters of living beings are derived from those of the environment. To do this in detail would involve retracing the course of evolution. Obviously, this can be done only in outline; but a necessary presupposition of any such undertaking is that the chemical elements which form the inorganic cosmos possessed from the beginning of organic evolution such a constitution and such modes of interaction as to render possible the production of living beings. By some thinkers this statement may be understood to imply that life was implicit or potential in the universe from the very first. But to the scientific investigator such a statement can have little meaning, since it is remote from the possibility of verification. He might even regard it as one more of the many useless and distracting freaks of verbalism. In point of fact, the course of scientific inquiry is little affected by such considerations.

From another point of view, however, such a statement ceases to be a truism, and acquires significance as one form of the philosophical insistence on the essentially unitary nature of the cosmos. The problem of vitalism is then seen in a clearer light. On the interpretation of natural science the evolutionary process can have followed only one course. Just why evolution has followed the course leading to the present outcome is a problem for philosophy rather than for science. Most scientific men agree that natural science aims at describing phenomena and tracing their interconnections, and does not try to account for the existence of nature itself. Now the problem of the place of living beings in nature has both its scientific and its philosophical aspects. The biological vitalists have tried to account for the physico-chemically unanalyzed peculiarities of organisms by assuming the existence of special extra-physical vital agencies (entelechies and the like). Dr. Henderson's discussion of this problem regards all such solutions as inadmissible. Since we can not separate living beings from their environment, it is clear that organisms must, from the scientific point of view, be considered and investigated in the same manner as the environment, *i. e.*, as the rest of nature. The vitalism of Driesch and Bergson is thus discountenanced, and insistence is made on the adequacy of the physico-chemical methods of investigating life-phenomena. The author believes that the only possible form of vitalism is one which regards the entire cosmic process as in its essence and from its inception biocentric in character. This is obviously a philosophical rather than a scientific point of view, but it has the advantage of interfering in no way with a scientific consideration of life or of any other natural process; and in the reviewer's opinion also it is the only tenable form which vitalism can assume. It is difficult to see how scientific exception can be taken to such a doctrine. It has, in fact, been held

[4] Equilibrium of processes, and not simply of static conditions, *e. g.*, a whirlpool, candle-flame, etc.

by various philosophers, though hitherto by relatively few scientific men.

It is evident on closer consideration that the existence and peculiarities of organisms must become completely unintelligible *except* on the assumption of a rigid and unvarying uniformity in the essential character of the processes taking place in living matter. The existence of material systems of such extreme complexity, which nevertheless maintain a stable existence and act in a manner which is uniform and within limits predictable—so that each human individual has a definite personal character—is in fact the most convincing proof that could be asked of the uniformity and invariability, as regards both their nature and their interconnections, of the innumerable substances, conditions and processes underlying the vital manifestations. Not only is the assumption of an extra-physical entelechy unnecessary, but it renders more difficult instead of easier the task of biological analysis, since it introduces a factor whose operation is *ex hypothesi* inconstant and unpredictable, and hence incompatible with the stability that vital conditions require. The assertion of Bergson that the living organism is characterized by a maximum of indeterminism[8] makes the organic mechanism completely unintelligible, and to a physiologist seems almost the precise inverse of the truth. It is evident that in any physiological process any even momentary variation or deviation from a constant physico-chemical mode of action—say any inconstancy in the law of mass-action—would derange the whole interdependent system of processes, and render continued life impossible. The organism constitutes in fact the most impressive illustration that nature offers of the unfailing constancy of natural processes. The course of embryonic development is as essentially constant a process as the revolution of the moon about the earth, besides being far more complex; and this stability of the organic processes is fully as necessary to the continued existence of the species as is that of the inorganic processes. The usual forms of vitalism are hence inherently unintelligible and self-contradictory. It is certain that the advance of physical science, and especially of biological science, offers no escape from the deterministic dilemma. Experience shows everywhere not only interconnection between phenomena, but an invariability in the modes of interconnection. Constant repetition always exhibits itself as the order of nature, when the elementary constituents and processes are observed. The question inevitably arises: how then is it possible to reconcile teleology and the existence of will and purpose in nature with the existence of a physico-chemical determinism which appears the more rigid the further scientific analysis proceeds? Such problems are usually left on one side by scientific men, and this is not the place for their fuller discussion. Obviously, however, they require biological knowledge for their solution—if, indeed, they are ever to be solved; and one chief merit of the book under review is that it directs the attention of biologists once more to the importance and urgency of these questions.

Ralph S. Lillie

[8] "Creative Evolution," Chapter 2.

The Interpretation of Dreams. By Sigmund Freud. Authorized translation of third edition by A. A. Brill. New York, The Macmillan Co. 1913. Pp. xii + 510. Price $4.

The "Interpretation of Dreams" is one chapter in Freud's theory of the neuroses, and was arrived at by the same methods which proved so useful in the study of the latter. This study revealed principles of even wider application than the sphere from which they were derived, and led to the author's illuminating psychopathology of every-day life. Similarly the dreams of normal people have become much more intelligible in the light of the analysis of psycho-neurotic symptoms and of the dreams of psycho-neurotic patients. Those who are familiar at first hand with the mechanisms of the neuroses and who are at home in the literature of the subject will find the "Interpretation of Dreams" an extremely stimulating monographic treatment of one aspect of a very large subject. To those who

are not at home in the realm of the neuroses, and who take up this book in the atmosphere of the study or the experimental laboratory and would try to correlate it with the psychological data with which they usually work, the book is apt to be startling, unconvincing, repellent. The latter would have no difficulty in finding easy openings for criticism, both as regards method and form of presentation. The criticisms which have been brought forward against Freud's whole theory of the neuroses will no doubt be brought up in relation to this book, to the effect that it is largely a question of assumptions, ingenious but far-fetched hypotheses, and unconvincing arguments lacking proof. As to what proof actually consists in hostile critics are apt to be discreetly silent. It must be remembered that the type of demonstration appropriate to one topic may be quite out of place in relation to another; the satisfactory proof of a paleontological thesis is something very different from a mathematical demonstration. The proof that a certain piece of flint is really an arrow-head and not a mere casual product of nature consists in showing its place in a large series, and the extent of that series, which the individual requires in order to be convinced, will largely depend upon the attitude of the individual. So the extent of the series of data required to convince a reader of the truth of certain principles as to the neuroses and dream interpretation will depend very largely on certain personal factors. The presentation of material must necessarily be comparatively limited and much depends on what the reader can himself supply to supplement the data of the book; if he should have no relevant data at his command then the whole theory of dream interpretation may seem highly artificial. Any one with wide experience must admit the essential truth of certain general principles, while reserving judgment on the conclusiveness of certain detailed interpretations.

The method employed by the author in the interpretation of the dream is that of free association, a method which he found useful in his psycho-analytic work. After the first chapter, which deals with the literature on dreams, Freud presents us an example of his method of interpretation of a dream, and in the succeeding chapters he defends his thesis that the dream is essentially the fulfilment of a wish: "The dream is the (disguised) fulfilment of a (suppressed, repressed) wish." The term wish must not be taken in too crude a manner, but is used to represent a variety of vague strivings and longings which are dynamic factors that frequently escape the notice of clear consciousness. The author demonstrates conclusively that dreams frequently represent wishes in an undisguised form, and that they often represent wishes in a more or less distorted manner. But he goes further; he maintains that the dream *always* represents the fulfilment of a wish. In two examples which the author quotes, the fact that the dream represents the opposite of the fulfilment of a wish is interpreted as showing that the patients desired to prove that Freud was wrong in his theory of the nature of dreams. This is one example of the subtlety of the author's argument which never leaves him at a loss, but which, on the other hand, is more ingenious than convincing. The argument, too, would be more satisfactory if the patient who wished to refute Freud dreamed that she was dreaming. The fifth chapter (pp. 138 to 259) is devoted to an analysis of the actual stuff of which our dreams are made, and the sources from which the material comes. The important thing is that behind the trivial and absurd manifest dream content, thoughts of serious personal significance are always found at work. Memories of childhood experiences here play an enormously important rôle. In this connection Freud takes up the analysis of certain typical dreams and gives many examples of the symbolism which occurs in dreams. His statements are frequently dogmatic, *e. g.*, with regard to the meaning of dreams about landscapes and localities of familiar appearance (p. 242). On the other hand, Freud himself draws the line at some of the interpretations advanced by Stekel. His criticism of his pupil is not altogether inapplicable to his own product: "These interpretations

seem neither sufficiently verified nor of general validity, although the interpretation in individual cases can generally be recognized as probable." In the sixth chapter the author discusses the manner in which the stuff of our dreams is woven into the final tissue, and he describes in detail the four main processes, viz., condensation, displacement, dramatization, secondary elaboration. In the final chapter, the obscurity of which is somewhat increased in the translation, the psychology of the dream activities is discussed in a general way. For this purpose Freud constructs a scheme of psychological activity which is extremely interesting and suggestive, but which on the other hand is peculiarly artificial.

Since its publication in the first German edition this book has met with a very mixed reception. The bible of the author's disciples, it has been derided by his opponents. Any person who has had to deal seriously with the problems of the psycho-neuroses and of the disordered mind in general, and who has been impressed with the value of the psychopathological principles derived from Freud's contributions for the general development of psychological and allied studies, will look upon this book as a serious contribution to a most important field. The more knowledge he has of the actual facts the slower will he be in dogmatically rejecting even those statements of the author which are unconvincing and apparently rather extreme. He probably is already firmly convinced of the truth of many doctrines which at an earlier stage of his own work he looked upon as equally far-fetched and perhaps even more absurd.

C. Macfie Campbell

Tables Annuelles de Constants et Données Numériques de Chemie, de Physique et de Technologie. Published under the patronage of the International Association of Academies by the international committee named by the Seventh Congress of Applied Chemistry (London, June 2, 1909). Vol. I. for 1910. Gauthier-Villars, Paris, University of Chicago Press. 1911. Quarto. Pp. xxxix + 727.

This first volume of the annual tables and numerical constants, published under the auspices of an international committee representing twenty-one countries, shows the prodigious undertaking assumed by the committee. The list of collaborators comprises no less than thirty-one distinguished scientific authorities, and the number of abstractors of scientific journals about three times as many. The book is divided into forty-six chapters, and the table of contents covers eighteen pages in French, German, English and Italian.

The material is admirably arranged, and to every table are appended the name of the investigator and a reference to the original memoir. Thus, every item may be verified by consulting the original publication. Every scientific worker in the fields covered by this volume has in condensed form the results of allied investigations and information relative to the original sources. Moreover, the general secretary offers to assist in obtaining fuller information concerning memoirs in journals not accessible to the reader.

It is difficult to conceive of any compilation of scientific data better adapted to furnish information to the investigator in physics, chemistry and technology. A close inspection of the contents of this volume reveals a wealth of data and a variety of subjects that command not only respect but admiration. The investigator has in this book an invaluable adjunct to his reference library of scientific books and periodicals. It will broaden his view of the particular field of research in which he happens to be engaged, and will give him collateral information relative to many other allied subjects. The fulness of this information is indicated by the data relating to conductivity of electrolytes and electromotive forces, which cover forty-six large quarto pages. Under the first come specific conductivities, molecular conductivities, constants of electrolytic dissociation, transport numbers, coefficient of pressure of electrolytic conductivity, conductivity of electrolytes in solvents other than water, conduc-

tivity of electrolytes in a mixture of solvents, and conductivity of a mixture of electrolytes in pure solvents. The tables of electromotive forces include those of normal cells, of transition cells, of concentration cells, the potential of simple electrodes, and divers unclassified electromotive force effects.

In addition to the above there are forty-seven pages devoted to data in general electricity and magnetism. Immediately following these are eight pages on radioactivity and ionization. The writer finds nothing on the Peltier effect or on the important subject of electrolytic thermo-electromotive force.

A bibliography is appended to every main division of the book. An alphabetical index would add much to the convenience of reference. The second volume for 1911 contains both a general and a special alphabetical list of all substances mentioned in both volumes.

HENRY S. CARHART

SPECIAL ARTICLES

AN ILLUSTRATION OF THE INFLUENCE OF SUBSTRATUM HETEROGENEITY UPON EXPERIMENTAL RESULTS

IN experimental breeding so much stress has been laid upon controlled fertilization that some other factors of importance for the obtaining of trustworthy results have been left too much out of account. The importance of heterogeneity in the substratum upon which the plants are grown as a possible source of error has been pointed out time and again. De Vries, for example, attaches great weight to this factor.

The purpose of this note is to give point to these warnings (too greatly neglected now) by showing how extrinsic influences may completely screen intrinsic tendencies.

In very extensive series of materials a positive correlation has been demonstrated between the weight of the seed planted and the number of pods on the plant into which it develops—that is, yield is higher in the plants from the heavier seeds. This is true without exception for twenty series, involving 13,099 plants, already published.[1] Further constants based on 4,856 plants, are given below. Here the coefficient of correlation, r_{wp}, shows the relationship between the weight of the seed planted (in the conventional units of .025 gram range) and number of pods per plant, while the second term of the regression straight line equation,[2]

$$p = \left(\bar{p} - r_{wp}\frac{\sigma_p}{\sigma_w}\bar{w}\right) + r_{wp}\frac{\sigma_p}{\sigma_w}w,$$

shows the absolute change in number of pods per plant for each unit change in seed weight.

Series	Number of Plants	Coefficient of Correlation and Probable Error	Regression Straight Line Equation
GGH.....	583	$.208 \pm .027$	$p = 1.931 + .539w$
GGD.....	514	$.159 \pm .029$	$p = -3.504 + .361w$
GGDD.....	342	$.137 \pm .036$	$p = -1.967 + .279w$
GGHH.....	396	$.194 \pm .033$	$p = -2.321 + .513w$
GGD_2.....	449	$.215 \pm .030$	$p = -4.861 + .436w$
GGH_2.....	499	$.176 \pm .029$	$p = -1.037 + .485w$
GG.....	750	$-.368 \pm .021$	$p = 17.418 - .403w$
LG.....	182	$.066 \pm .050$	$p = 2.351 + .134w$
LL..... ...	1141	$-.009 \pm .020$	$p = 7.245 - .012w$

The constants are in excellent agreement with those already published—fairly large and positive throughout—with the exception of the Golden Wax, the *L* series, and the *GG* culture of Burpee's Stringless. Those for the Golden Wax series, *LG* and *LL*, are sensibly zero; one is the smallest positive coefficient yet found while the other is negative in sign, though only a fraction of its probable error.

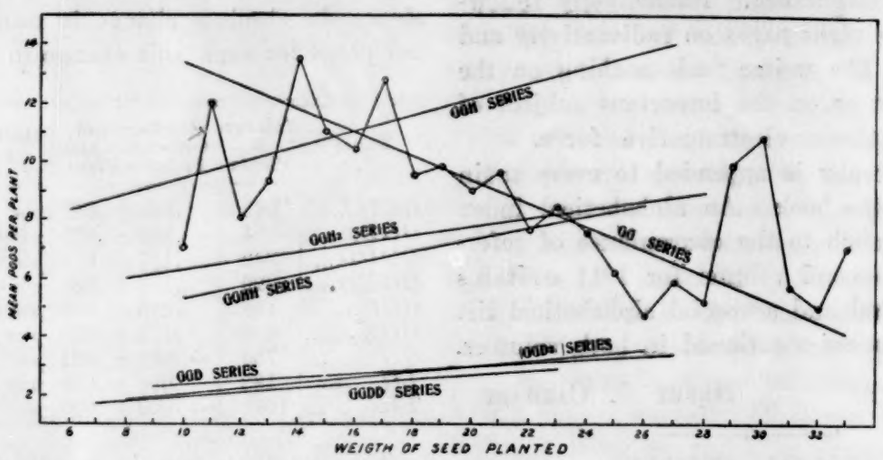
The coefficient for the *GG* series is in striking contrast to the others; not only is it numerically the largest value recorded, but it is negative in sign and unquestionably signif-

[1] Harris, J. Arthur, "The Relationship between the Weight of the Seed Planted and the Characteristics of the Plant Produced—I.," *Biometrika*, Vol. 9, pp. 11–21. See also *Amer. Breed. Mag.*, Vol. 3, pp. 293–295.

[2] p = pods per plant, w = weight of seed planted. The bars indicate the means and the sigmas denote the standard deviations of the characters in question. Through a slip in the copying of the manuscript which I overlooked in the proofs, the second term of the regression formula is given the negative sign on p. 14, *Biometrika*, Vol. 9. The values in the calculated equations are of course correct.

icant, being nearly eighteen times its probable error.

The comparison of the *GG* series with the other Burpee's Stringless cultures is forcibly brought out by the diagram. This shows the linear graduations (from the equations given in the table) of the number of pods per plant for various seed weight classes. Only the *GG* series, for which the empirical means are also



shown,[3] indicates a decrease in the number of pods associated with an increase in the weight of the seeds planted.[4]

The explanation of this result is simple. In each of these 29 experiments with the exception of the *LL*, *LG* and *GG* series, the seeds were individually labelled, thoroughly shuffled and planted at random over the field to counteract the possible heterogeneity of the soil.[5] In the case of the *LL* and *LG* series I suspected that the soil conditions were not strictly uniform, but the various "pure lines" were planted in numerical order across the field, just as is usually done. In the *GG* series the weight groups were planted in order across a garden plot *which was selected for its apparent uniformity of soil.* This was again in accordance with ordinary experimental practise.

But many unknowable factors are involved in the productive capacity of the soil and it appears that the particular parcel of ground selected, although only large enough to grow 750 plants, changed in productiveness from one side to the other. By chance the seeds were so planted that the smaller ones were given the best conditions. So great was the heterogeneity that it not only neutralized the influence of seed weight which is always demonstrated when experiments are made with proper refinements,[6] but actually brought about a negative correlation between weight of seed planted and number of pods produced *which is numerically the highest found in twenty-nine cultures!* Had the order of planting been reversed, both soil fertility and seed weight would have been active in the same direction, and an abnormally high positive correlation would almost certainly have been the result.

J. Arthur Harris

Cold Spring Harbor, L. I.,
June 10, 1913

[3] The inclusion of all the empirical means would have rendered the graph too confusing. Graphic tests made for each case affords no evidence that a curve of a higher order would be better than a straight line.

[4] For the *GGD*, *GGD*$_2$ and *GGDD* series the slope of the line is very slight. This is due simply to the fact that these cultures were grown under much more adverse conditions than the others, and such wide variation in number of pods per plant is not possible.

[5] The importance of this procedure has been emphasized in *Amer. Nat.*, Vol. 45, pp. 697–698, 1911; Vol. 46, p. 325, 1912.

[6] The seeds used in the *GG* series were the ancestors of those employed in all the other experiments with Burpee's Stringless. Thus there can be no criticism because of "differences between the pure lines used."